Learner Control versus Program Control in Interactive Videodisc Instruction: What Are the Effects in Procedural Learning?

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ABSTRACT

Interactivity has long been regarded as an important role in instructional design. It is commonly assumed that some degree of individual control over the interactivity is necessary for instruction. When given control, individuals may better learn how to learn, for they are allowed to determine their own pace, order, and choices. Furthermore, they may feel more intrinsically motivated for learning and may have a better attitude toward the instruction, which may ultimately result in better performance. In this study, fifty-two subjects were randomly assigned to a program-control or a learner-control treatment for procedural learning. The instructional task was to make an origami (Japanese paper folding) crane from an interactive videodisc presentation. Results indicated the learner control group significantly ($p < .05$) outperformed the program control group. However, the program control group spent significantly ($p < .01$) less time during instruction. Analysis of the self-efficacy and attitudes revealed no statistical difference between the two groups. The results suggest that learner control features of instructional design may be superior to program control and therefore should be integrated where feasible in procedural tasks.

Introduction

Interactive video instruction, one of the recent developments within the field of instructional technology, is receiving considerable nationwide attention by educators. Such a technology appears to be particularly appropriate for teaching procedural skills (Priestman, 1984) as well as professional preparation (O'Neill, 1989). Interactive video is defined as "any video program in which the sequence and selection of message is determined by the user's responses to the material" (Floyd, 1982, p.2). By requiring the learner's response, it captures the learner's attention and holds his/her interest to a greater extent than does linear-video alone (Heinich, Molenda & Russell, 1989). Cognitive learning theories provide justification for the role of interactivity in instructional design. It is assumed that deep, long-term understanding requires active, prolonged engagement and construction of meaning with the learning environment (Bruner, 1973). Research has demonstrated that students using interactive video may not learn more, but they learn faster and retain the information much longer (Donald, 1984). Thus, it is hypothesized that the student's active engagement in the learning tasks will be better achieved than passive engagement (Bruner, 1973). However, two primary questions are raised. First, "who should control the interactivity?". The learner or instructor/computer program? Second, "what should be controlled?". Variables that can be controlled during the instruction include sequencing, pace, difficulty and amount of practice. According to Merrill (1975, 1984), the concept of control refers to the freedom the learner or instruction/computer program has to take command of the selection and sequencing of: 1) content control; 2) display control; and 3) conscious cognition control.

Learner control can be defined as the degree to which a learner can direct his/her own learning process. The belief that learners should be involved in choice-making on control of learning has been widely held in many educational settings (Carrier, Davidson, Higston & William, 1984). Merrill (1975) suggested that the learner should be given control. With such control, he asserted, individuals can better learn how to learn. They make instructional decisions, experience, the results of those decisions, and in the process discover the best tactics for different situation. Through the process, individuals can learn how to effectively adapt to the different learning situations that make up the real world (Kinzie, Sullivan & Berdel, 1988). In the Component Display Theory (Merrill, 1983) and Elaboration Theory (Reigeluth, 1983), Merrill and Reigeluth both indicated that the instruction generally increased in effectiveness and efficiency by permitting learner control. Additionally, motivational theorists, such as Lepper (1985) have indicated that as a result of learner control, the individual feels competent and self-determining, and the activity has greater personal meaning and intrinsic interest. Also, Papert (1980) in his work with LOGO argues that increasing control enhances feelings of self-efficacy and assists learners in taking independent responsibility for their own learning and behavior.

However, research has shown mixed results for learner control. While some results suggested that individuals learned more when given control over their learning (Campanizzi, 1978; Gray, 1987), other researchers demonstrated that learners making instructional control decisions did not learn as effectively as those who had those decisions made for them (Fisher, Blackwill, Garcia & Greene, 1975).

Contradictory results have also been obtained when student attitudes are considered. Fry (1972) reported that more positive student attitudes were found from learner control than from program control. Fisher and colleagues (Fisher et al., 1975) indicated that when a learner-control treatment was used, it was found that the students had greater engagement in learning. However, as Clark (1980) pointed out, what a student preferred was not necessarily what was best for the student. The inconsistent results may be accounted for by variations in the computer-aided-instruction (CAI) design, the nature of the learning task and the types of control offered. For example, the strategies for teaching rules and application may be different from those used to teach concepts or other skills. And, the type of control may be varied in content, pace, display, or conscious cognition (Merrill, 1984).

An alternative to learner control research has been studied as "learner control with advisement", where the learner is able to make some decisions as to content, sequence, etc., while the program makes suggestions for some of those choices (Milheim & Azbell, 1988). Tennyson (1981) has found that, given advisement, learners can control their own instruction quite effectively. Tennyson and Rothen (1979) state that such advisement may be necessary since typical learner control strategies may fail to provide students with the necessary cognitive information about their learning progress by which they can make meaningful decisions (Tennyson & Rothen, 1979). Several studies have suggested that learner control groups receiving advisement information generally had higher posttest means, had more students in reaching mastery, needed less instructional time and needed fewer instructional instances than a learner control group without advisement (Hannafin, Garhart, Rieber & Phillips, 1985; Johansen & Tennyson, 1983; Tennyson, 1980).

The use of learner control has also been shown to be affected by learner's prior knowledge of the instructional task. For instance, Gay (1986) demonstrated that learner control would be more efficient only under the assumption that subjects had prior conceptual understanding of the content area. Similarly, Fry (1972) indicated that the use of learner control actually increased performance when the students had high entry aptitudes or abilities.

Among the previous topics studied in the area of learner control were teaching mathematics (Goetzfried & Hannafin, 1985; Ross & Rakow, 1981), binary arithmetic (Holmes, Robson & Steward, 1985), solar energy (Kinzie, & Sullivan & Berdel, 1988; Kinzie, Sullivan, Beyard & Berdel, 1987), biology (Gay, 1986) and the National Gallery of Art (Hannafin, Phillips, & Tripp, 1986). These studies were generally oriented around declarative knowledge. However, the question arises: can we generalize those results to a procedural learning? Hannafin (1984) claims that procedural tasks and verbatim learning tasks are best taught using program control; contextual and substantive information are best taught using learner control. He stated, "whereas some learners may learn procedural tasks effectively under internally controlled [i.e., learner control] instruction, a greater proportion of learners will likely profit from an established instructional sequence [i.e., program control]..." (1984, p.8).

In the current study, a procedural task was used and display control was offered. The major focus of this study was to examine the effects of pre-advised leaner control and program control on the student performance, self-efficacy concerning the instructional task, time on task, and attitudes toward the instruction. These have been found to be critical variables in providing outcomes in previous research.

The instructional task involved the construction of the origami crane. Origami is an ancient Japanese art in which animals and other figures are created from a series of intricate folds of a single sheet of paper. Origami was selected as the procedural task because the subject pool was likely to have little or no experience with it.

Methodology

Sample

Subjects were 52 volunteers from an undergraduate Educational Psychology class at the University of Connecticut. All subjects received extra credits for participation and additional credit depending on their achievement at or above two-thirds of the highest point available. The additional credit was used to provide motivation for students to perform at high level.

Materials

The instruction was the videodisc "Making an Origami Crane" section from the First National Kidisc by Optical Programming Association (Green, 1981). The sequencing of the videodisc instruction was programmed and controlled by the BASIC language of a microcomputer. The instructional time for this task takes approximately 25 minutes to finish. Origami is the ancient Japanese art of paper folding to create figures. The origami crane is a paper-folded bird figure.

Treatments

Two instructional treatments were used: program-control and learner-control in a computer-based interactive videodisc program on making an origami crane. The instructional video was the same for both the treatments. The whole program consisted of an introduction section, an overall section (in regular speed) and an overall section (in slower speed). The entire process for creating the crane figure was: 1) making crane base; 2) making a crane body; 3) making wings; and 4) making a tail and a head. According to the sequence of the content, the overall section (in slower speed) was divided into different components, such as crane base 1, base 2, body 1, body 2, wings, and tail/head. The slower speed presentations were presented without narration.

Group 1 (The **Program-Control Condition,** N=26), was presented an introduction, a summary of the procedure (in regular speed), and the overall program, divided into 12 sequenced steps in a slow motion. Subjects were asked at each step whether they would like to see the sequence again. If the answer was "YES", the program would display that sequence again. Subjects were able to see a segment as many times as they wanted, within each step. But once they went to the next step, the could not go back to view the previous sequence. The order of the steps was the same for all subjects in this group. The flowchart of the program-control program is illustrated in Figure 1.

Group 2 (The **Learner-Control with Advisement Condition**, N=26), was provided the same introduction as Group 1, but rather than forcing subjects to go through the whole program in the pre- determined sequence, they were provided a menu to select the instructional segments they wanted to see. Subjects were also provided a suggested path (i.e., advisement) before the program began. Subjects were able to go through the program based on their own choices of sequences. At each instructional segment, they could repeat, stop, and continue at a certain point. Group 2 was able to view the instructional sequence in any order they wished. They could also go back to any segment they wanted to see again or skip ahead to other sections at any time. The program flowchart is illustrated in Figure 2.

Procedures

Subjects were randomly assigned to two groups and individually instructed. All subjects who indicated experience with origami were eliminated from the study; only naive subjects were retained. All subjects were instructed how to operate the computer-based program properly before the treatments. Both groups were shown five models of completed origami cranes prior to instruction. They were not allowed to take the models apart.

All subjects were allowed to practice making a crane during the instruction. Subjects were provided several sheets of origami paper to practice during instruction. Subjects viewed the instructional video alone and were administered all tests and instruments individually.

Subjects in both groups were administered a measure of self- efficacy focusing on the creation of the crane after they saw the models, using a Likert-type 1-5 scale, (1= very little, 5= quite a lot) before and after the instruction (See Appendix A for the Self-Efficacy instrument). The attitudinal questionnaire was also provided to find out how subjects felt about the instruction which they were given, using a Likert-type scale from 1 (Never) to 5 (Always) (see Appendix B for Attitudinal instrument).

The amount of time for each subject's instructional time on task and time on testing were recorded by the computer. There was 30 minute time-limit for instruction and 10-minute for testing. No subjects required extra time to finish either the instruction or the test.

Subjects were permitted to use as many sheets of origami paper as they wanted during the test, but they submitted only one origami crane which they considered as the most successful one.

Cranes were scored on a holistic 0-6 scale. There were six major parts for the crane construction (see Table 1). Three origami crane experts scored each crane. The mean inter-rater reliability was .983.

Results

The analyses were divided into two parts, both using t-tests. The first analysis centered on the major focus of the study, the difference in performance of the origami task. The t-test, using a one-tailed procedure, resulted in a significant ($t=1.79, df=25, p<.05$) difference between the two groups demonstrating the superior performance of the learner control group.

The second group of analyses employed four separate t-tests comparing the two groups on pre-self-efficacy, post-self-efficacy, time on task, and attitudes toward the instruction (see Table 2). Due to the use of multiple t-tests a Bonferroni adjustment was used ($p<.01$) in order to maintain the overall experimental alpha level of $p<.05$.

The results of t-tests indicated no significant difference between the learner control and program control groups on pre-self-efficacy, post-self-efficacy, and attitudes toward the instruction ($p > .01$). However, the two groups were significantly different in the amount of time on task (t=-6.48, df=25, $p < .01$), with the learner-control group using more time for instruction.

Conclusions

In this study, the statistically significant difference on performance scores (making an origami crane) (p= .039) supports the general hypothesis that learner control will significantly increase task performance. It also supports Merrill's (1975) theory, that given some control over instruction, the learner could effectively determine how best to learn in a given situation, but does not support Hannafin's (1984) argument that procedural tasks are best taught using program control.

Additional analyses revealed no significant difference between the two groups on the attitudes toward the instruction, pre-self-efficacy, and post-self-efficacy. These results may be attributed to the novelty effect of the equipment and task for both groups.

Learner-control subjects took significantly more time to complete the instruction than program control subjects. This result may be explained by the following premise; that without giving any previous knowledge of the origami techniques, the learner-control group needed more time in understanding the program's pattern in order to make their own choices. Interestingly, a 30-minute experimental time was more than adequate for both groups. The subject self-report data suggests that the learner-control subjects used the additional time to review the instruction.

Although the performance of subjects under learner-control supports the results of some past learner control research (e.g., Goetzfried & Hannafin, 1985; Gay, 1986; Kinzie et al., 1988), variations in the CAI instructional design, particularly in the types of instructional support and control offered must be examined to prescribe the optimal instructional presentation. Varying levels of control and instructional support should be further investigated for their effects on achievement across different content areas, learners, and instructional situations. Gay (1986) suggested learners should be given more control if their prior understanding of a topic was relatively high; conversely, learners should be provided with more structure (program control) if their prior conceptual understanding of a topic was low. In future research, subject's prior knowledge, attributional style, aptitudes and motivation should be considered as potential variables in the study of learner control and interactivity.

TABLE 1

Criteria of Crane Scoring System.

Score	Criteria
0	Nothing.
1	Only Base 1.
2	Only Base 1 and Base 2.
3	Only Base 1, Base 2 and Body 1.
4	Only Base 1, Base 2, Body 1, and Body 2.
5	Only Base 1, Base 2, Body 1, Body 2, and either Wings/Tail or Head.
6	Perfect.

TABLE 2

Results of t-Tests on Performance Scores, Pre-Self-Efficacy (PRE-SE), Post-Self-Efficacy (POST-SE), Time on Task (TOT), and Attitudes toward the Instruction (ATTITUDE) for Group 1 (Program-Control) and Group 2 (Learner-Control).

VARIABLE	MEAN	STD	t VALUE	PROB.
Score	G1 = 3.13 G2 = 4.23	2.36 2.07	1.79	0.039 *
PRE-SE	G1 = 2.92 G2 = 3.08	1.52 1.64	-0.41	0.342
POST-SE	G1 = 2.96 G2 = 3.00	1.34 1.27	-0.11	0.456
TOT	G1 = 1102.85 G2 = 1819.81	451.02 339.33	-6.48	0.000 **
ATTITUDE	G1 = 4.13 G2 = 4.10	0.75 0.56	0.21	0.419

* $p < .05$ ** $p < .01$

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FIGURE 1. PROGRAM FLOWCHART: PROGRAM-CONTROL

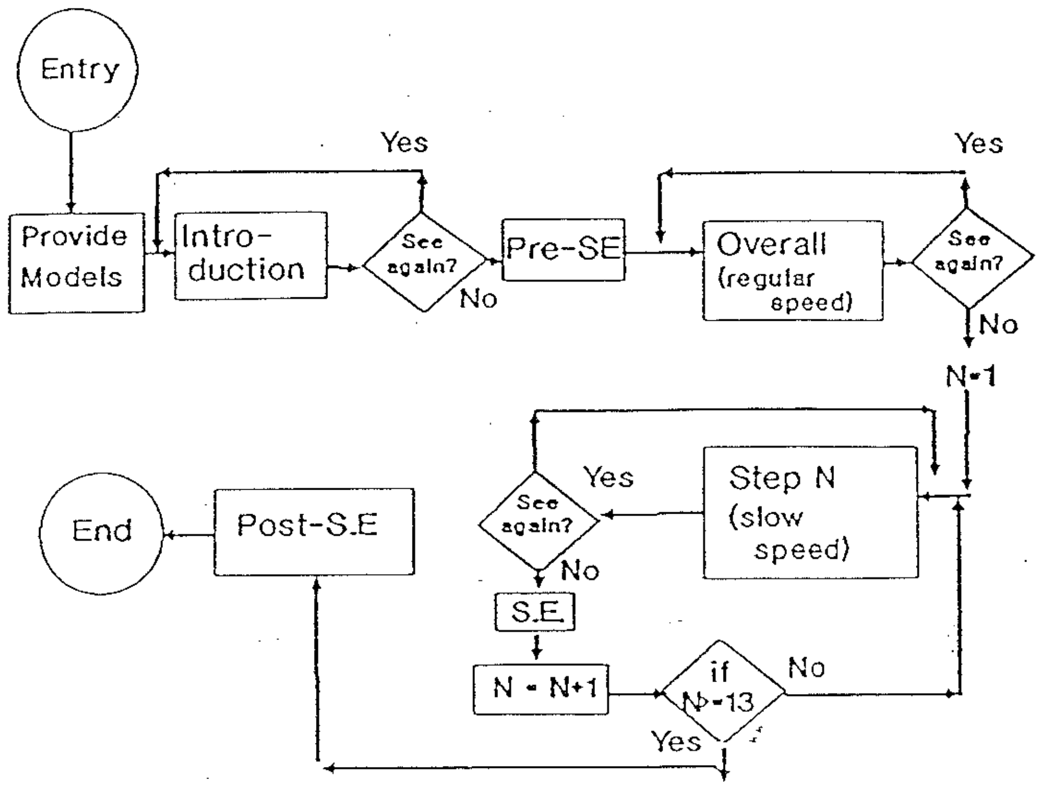
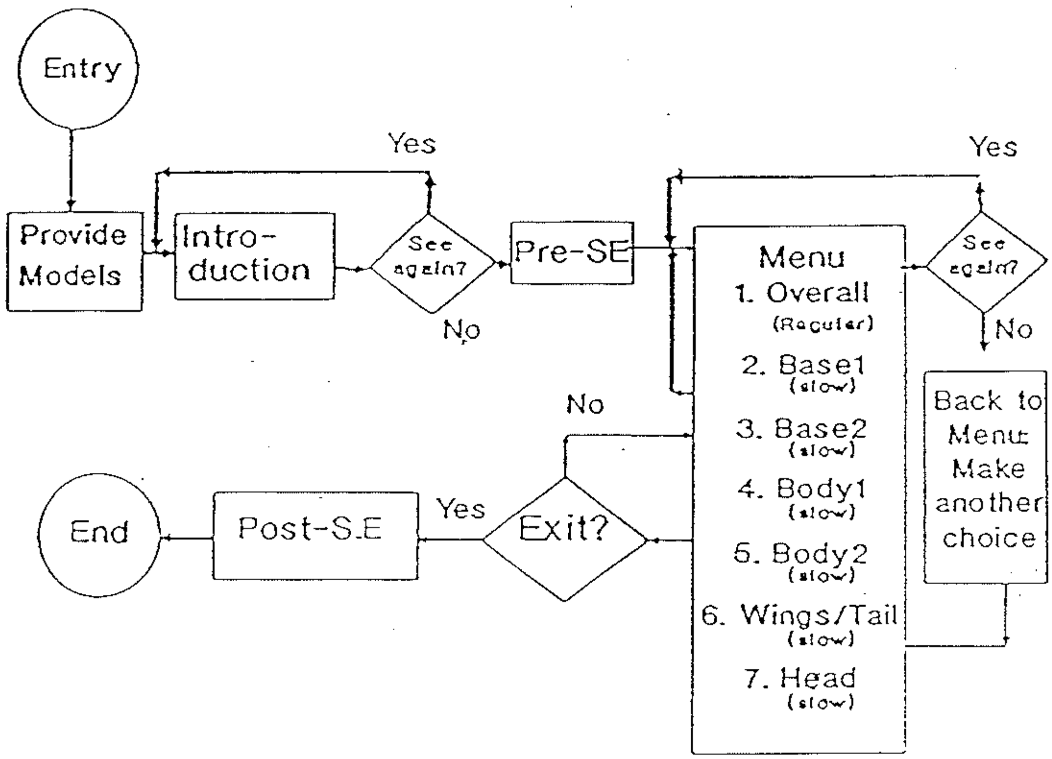


FIGURE 2. PROGRAM FLOWCHART: LEARNER-CONTROL



APPENDIX A: SELF-EFFICACY INSTRUMENT

How confident are you on a scale 1-5 that you will be able to build this crane?

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1 VERY LITTLE	2	3	4	5 QUITE A LOT

APPENDIX B: ATTITUDINAL QUESTIONNAIRE

	NEVER				ALWAYS
1. Were the instructions clear?	1	2	3	4	5
2. Was the program easy to use?	1	2	3	4	5
3. Did the program capture your interest?	1	2	3	4	5
4. Did you feel that you had control of the program?	1	2	3	4	5
5. Was the picture and sound quality good?	1	2	3	4	5
6. Did you feel that the video was an important part of the instruction?	1	2	3	4	5
7. Did this program improve your understanding of the subject matter?	1	2	3	4	5
8. Did you enjoy this learning experience?	1	2	3	4	5
9. Would you participate in an interactive video learning activity again?	1	2	3	4	5

What did you like about using interactive video?

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What didn't you like about using interactive video?

____